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ABSTRACT

The status of mathematics education in schools in Samoa is a major concern to post-secondary mathematics educators. Incoming students from secondary schools are not adequately prepared for advanced studies in mathematics for lack of a solid understanding of basic mathematics principles which is essential for further studies in calculus and linear algebra. This paper provides a general overview of national examinations results and selected comments from examiners' reports to illustrate the state of mathematics education in Samoan schools. The quality of mathematics learning in schools directly impacts on first year programs in post-secondary institutions as time is often taken out to bridge students up to the appropriate mathematics entry level. The paper briefly describes some of the research and professional development activities organized by the University in an effort to impact on the teaching of mathematics within its teacher training programs. (Contains 39 references.) (Author/MM)

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A Samoan Perspective on Pacific Mathematics Education

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The status of mathematics education in schools in Samoa is a major concern to post-secondary mathematics educators. Incoming students from secondary schools are not adequately prepared for advanced studies in mathematics for lack of a solid understanding of basic mathematics principles which is essential for further studies in calculus and linear algebra. This paper provides a general overview of national examinations results and selected comments from examiners' reports to illustrate the state of mathematics education in Samoan schools. The quality of mathematics learning in schools directly impacts on first year programs in post-secondary institutions as time is often taken out to bridge students up to the appropriate mathematics entry level. The paper briefly describes some of the research and professional development activities organized by the University in an effort to impact on the teaching of mathematics within its teacher training programs.

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This paper focuses on the state of mathematics education in Samoa. However, because of similar historical developments in their political, economical and educational systems, and common traditional and cultural backgrounds, many of the issues plaguing Samoa's educational sector are also common in the rest of the island countries. This paper is organized into four parts. The first part discusses the general state of school mathematics as indicated by national examinations results in the last five years (1996-2000) to provide the general mathematics environment which nurture students for further studies at tertiary level including the National University of Samoa (NUS). Included also are selected comments from examiners' reports that are indicative of main concerns for each national examination. The second part defines the problem that is prevalent in mathematics classrooms in Samoa as indicated by national results and manifested through the performances of students that enroll in NUS mathematics courses. The third part provides a brief discussion of various philosophical perspectives on mathematics and mathematics education to illustrate how these views can influence the way mathematics may be taught and assessed in the classroom. The fourth part presents a synopsis of on-going research and professional development activities conducted and organized by NUS as part of its on-going efforts to re-dress low pass rates in its mathematics courses and to meet the training needs of Samoan mathematics teachers.

National Examinations - Primary Level

National literacy and numeracy testing started recently as a direct result of the UNESCO PILL Report (UNESCO, 1992) which raised the alarm on Samoa's national literacy rates. Subsequently, Samoa's Primary Educational Literacy Levels (SPELL) Tests I (Year 4) and II (Year 6) were established and designed to monitor national standards. The tests are also important for the identification of students who are not achieving minimum competencies in both literacy and numeracy in schools. (Department of Education (DOE), 1999a, 2000a). The results (recorded as "at-risk percentages") track the proportion of total students at each level that are not achieving prescribed minimum competencies. The trend to date (1996 – 2000, Figure 1) shows that the Year 4 'at risk' percentage usually doubles

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by the time the same cohort is tested again in Year 6 (DOE, 1999a, 2000a). *This is a concern to the DOE including those at NUS.* Of particular importance to NUS is the implication in terms of both pre-service and in-service mathematics teacher education. Within the pre-service teacher education program, mathematics content courses are the responsibility of the Mathematics & Statistics Department (MSD). Thus, the state of mathematics education in schools directly impacts on the mathematics "readiness" or lack thereof, of incoming students to cope with pre-degree and degree content courses in mathematics.

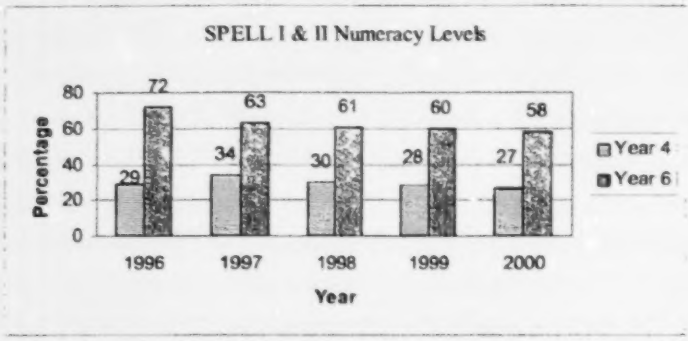

Figure 1. Years 4 & 6 Numeracy at-risk percentages.

At primary level, in spite of the decreasing Year 6 'at-risk' percentages over the period, see Figure 1, the amount of more or less 60% is still too high. This means that more than half the students in Year 6 each year in the last five years continue to underachieve. In fact, the examiner's report suggested that regular professional training for Year 4 and 6 teachers should be conducted to create awareness and develop effective strategies to help students improve their basic literacy and numeracy skills. Furthermore, the high 'at-risk' percentage in Year 6 may also be indicative of limited access to, or lack of supplementary and remedial materials for students (DOE, 2000a). A host of factors may be contributing to this poor performance such as poor mathematics knowledge and pedagogical skills of primary teachers, unavailability of relevant resources to supplement classroom teaching, and low level of institutional support for teachers and students; collectively they contribute to teaching and learning styles that promote rote-memorization. (DOE, 1986, 1995).

At the end of primary level is the Year 8 national examination established mainly for the selection of students to enter the top five government secondary schools. Of concern is the continuous low pass rates (those with raw scores $\geq 50\%$) in mathematics. In particular, it decreased from 21% (1998) to 16% (1999) with a slight improvement to 18% in 2000. These low pass rates are symptomatic of problems in the teaching and learning of mathematics either through lack of resources such as textbooks for both teachers and students, and/or poor content knowledge and pedagogical skills of teachers which translates to incomplete coverage of prescribed syllabus. Under these circumstances, students often resort to rote-memorization of procedures and entire answers that are reproduced at random during exams. In fact Year 8 Examiners' Reports continuously point out that the majority of students "(are) guessing what the answers might be" oftentimes quite unrelated to given questions, and "solving word problems (is) the most common weakness." Moreover, students appear to lack "basic understanding of mathematics operations and their sequence ... to get the correct answers" (DOE, 1999b, 2000b).

National results up to this level consistently show that girls perform better than boys. Raw means are consistently low at < 35% as shown in Figure 2 below.

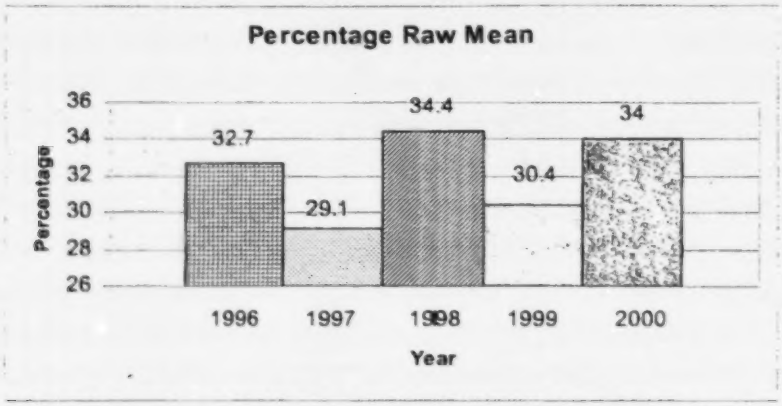

Figure 2. Year 8 National Examination Raw Means 1996 – 2000.

Given the poor numeracy results at Year 6, the consistently low pass rates and raw means at Year 8 is further confirmation of the level of mathematics learning in most primary classrooms. The 2000 Examiner's Report (DOE, 2000b) further re-iterates this poor performance particularly in both mathematics and science as well as the continual lowest ranking of mathematics' raw means out of all examinable school subjects each year.

National Examinations - Secondary Level: Years 11 - 12

The Years 11, and 12 national mathematics examination results in Figure 3 show that the raw means are all below 36% (DOE, 1999c, 1999d, 2000c, 2000d). Of the 2473 Year 11 students in 1999, only 14% passed whilst only 37% of the schools achieved raw means above the national mean. The Examiners' Reports pointed out that in sections where students had to show their working, most scripts were either left blank or had answers that were totally different from questions. According to the examiners, these actions "... reflect the lack of ... skills like knowledge, understanding, interpreting and application." It was recommended "that the (above) learning skills (should be) developed to improve (students') language ability in problem solving" (DOE, 1999c, 2000c).

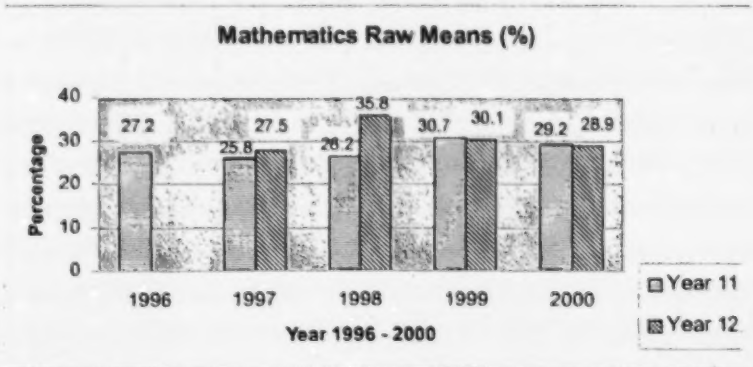

Figure 3. Years 11 & 12 Mathematics National Examinations.

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On the other hand, the Year 12 national results showed low varying raw means (27% to <36%) in the last five years. It was reported also that only 14% of 1913 students passed in 1999 (DOE, 1999d), decreasing to 10% (of 1845) in 2000 with a slight increase to 13% (of 1956) in 2001 (DOE, 2000e, 2000f, 2001). The poor results depicted in Figure 3 is alarming and a major concern to those teaching mathematics at Year 13 and beyond. Evidence from examination scripts showed that students had difficulties transferring their skills with numerical expressions to algebraic ones, effectively applying mathematics concepts such as ratio and proportions to real life situations, correctly expressing problems in mathematical statements, and misunderstanding/misinterpreting basic mathematical terms. For the majority of students, their performances appear to deteriorate as they advance from primary through to secondary level. Common difficulties and misconceptions appeared to be carried over to subsequent levels as evidenced by similar recurring comments across examinations. For those entering pre-degree programs at NUS, their weak understanding and ineffective application of fundamental principles to solve problems permeate their study of mathematics and impede their abilities to cope with more advanced mathematics.

Regional PSSC Examinations Year 13 – Secondary Level

Students who satisfy an institution's selection criteria (based on Year 12 results) continue onto Year 13, the final year of secondary level. However, unlike other Pacific Island countries which have restricted intakes for the Regional Pacific Senior Secondary Certificate (PSSC) examinations at Year 13, Samoa gives as many students as possible the opportunity to study at this level. Subsequently, its national scaled means are often 2% to 5% below regional scaled means and consistently below the 50% pass mark over the years, *see* Figure 4 below. Gender performance in Samoa in terms of grade averages show that boys consistently do better than girls over the years (South Pacific Board of Educational Assessment (SPBEA), 1999, 2000). (Note that the reverse trend characterises national primary examination results.) The regional raw means over the years are also shown in Figure 4 as they may "indicate the changing teaching and learning standards of the region or that the papers are changing in their level of difficulty" (SPBEA, 2000). The consistently low scaled means (under-50%) suggest that in spite of increasing enrolments in the PSSC examinations, many students continue to under-achieve in mathematics.

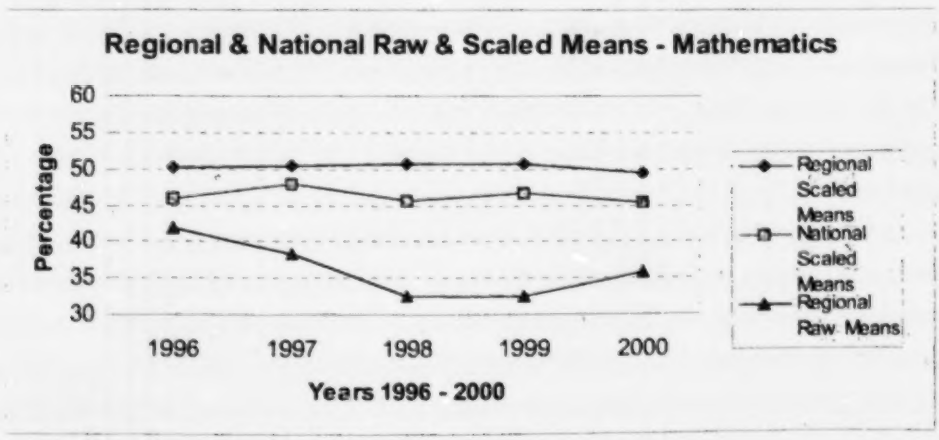

Figure 4. PSSC Mathematics Raw & Scaled Means.

University Preparatory Year (UPY) - NUS

After PSSC, admission into the UPY level at NUS, is determined by attaining a minimum aggregate score (usually 15) on the PSSC examinations. In the last two years, about 20% of Year 13 students qualified to enter UPY. About two-thirds of this group usually form the science and commerce streams in which mathematics and/or statistics are requirements. In particular, the required sequence for science students is MAU01: Algebra & Trigonometry (Semester 1) and MAU02: Calculus (Semester 2) whilst STU01:Statistics is available as an option. In comparison, the required sequence for commerce students is MAU03:Algebra and STUOI:Statistics. Although both sequences are available to social science students as electives, very few choose mathematics/statistics at this level. Figure 5 shows pass rates for all mathematics and statistics courses in the period 1996 to 2000. It should be noted that pass rates for MAU02 were much higher when eligibility was conditional upon a pass in MAU01 (up to 1997).

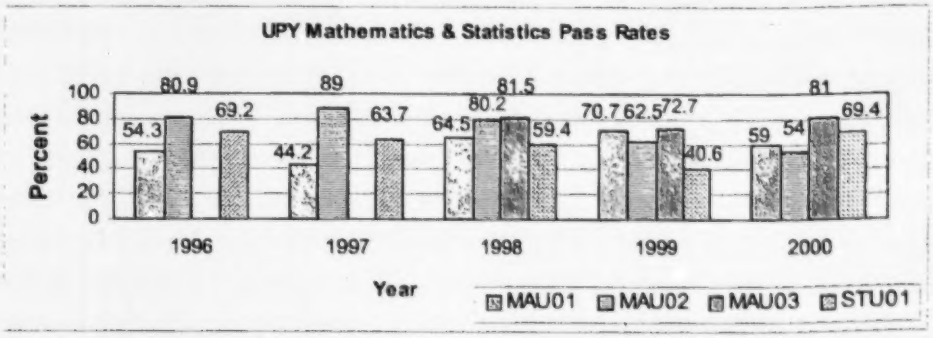

Figure 5. UPY Science, Mathematics & Statistics Pass Rates.

Although UPY students enjoy a high national ranking, these same students often experience difficulties in effectively applying basic mathematics concepts, axioms, and principles to solving given problems thus hindering performance at recommended levels in algebra, trigonometry, statistics, and calculus. As a consequence, the prescribed two-semester curriculum to prepare them for university studies is severely comprised as time is taken out for remedial work. Most of the misconceptions at this level are well ingrained and often difficult to overcome in the first semester without some sacrifices for both student and lecturer for extra work outside of scheduled class time. It is desirable therefore for students to develop a more solid understanding of fundamental mathematics concepts and principles while at primary and secondary levels in addition to being proficient in applying operations and executing procedures.

In summary, and on the basis of examiners' reports, it appears that students right across the levels have difficulties understanding, and interpreting the language of given problems. It is desirable to be proficient in executing a sequential procedure. However, when it is applied indiscriminately contrary to the intention of the problem then the action signifies a misinterpretation of the problem context and may be suggestive of rote-memorization learning styles. These weaknesses are symptomatic of a lack of a deep understanding of the conceptual structure of mathematics and poor meta-cognitive skills. Meta-cognitive skills include the abilities to control and monitor the activity of problem solving, to identify appropriate strategies and methods required by problems, and to know how and when to use these methods to successfully solve problems. Given that meta-

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cognitive activities improve achievement but that students may not automatically use them, it is suggested that students be taught these activities and encouraged to use them (Belmont, 1989). There is, therefore, a need to undertake research in Samoan classrooms to examine ways in which students understanding of mathematics could be improved, and subsequently conduct professional development programs for Samoan mathematics teachers that are informed and guided by research findings.

The Problem

The general problem is, therefore, the pervasive poor state of mathematics teaching and learning that seems to exist at all levels in Samoa's educational system. A number of interacting factors may have contributed to the existing situation ranging from ministerial, community and institutional support for classroom teaching and learning to teacher's mathematical beliefs and background, mathematics curriculum, classroom socio-cultural practices, national and school assessment procedures, and the students themselves. However, this paper will focus only on students, their learning environment within the classroom, and the problem of how their understanding of mathematics can be improved. It is acknowledged that students' mathematical beliefs and learning styles are very much influenced by what is regarded as important and legitimate by the ministry, institution and community at large as enacted within their school environment. In particular, national, regional and post-secondary mathematics results suggest that Samoan students have difficulties interpreting and effectively solving word problems, justifying and rationalizing solutions consistent with problem contexts; in effect a predominantly procedural, and narrow view of mathematics. Overall, they are mathematically illiterate in the view of Richards (1991) as defined below. Subsequently, some concerns and issues arising from students' performances in national examinations and at NUS may be collectively categorized into four types namely problem interpretation, transfer and application of knowledge and skills to new situations, and rote-memorization of procedures, and a fourth category that is more related to teachers' role concerning the incomplete coverage of prescribed syllabus during the school year. This categorization facilitates discussion but all four interweave and are mutually dependent on each other. For example, problem misinterpretation connotes language problems, which may be due to unfamiliar terms students may have never seen before thus they cannot comprehend the question. This may mean that the topic was not properly taught if at all (type 4) thus the tendency may be to just write down anything for an answer. However, even if the terms are familiar, students may not possess the relevant knowledge and meta-cognitive skills to effectively evaluate the applicability or not of identified methods and strategies and past experiences to successfully solve problems (types 2 and 3).

According to Richards (1991), "... the traditional structure of classroom instruction (and practice) are patterned after a faulty perception of mathematical activity. Students are not able to conduct and maintain a mathematical discussion; communicate *(discuss, evaluate, explain, describe)* the mathematics as they may not understand the appropriate language, syntax or rhythm of a mathematical discussion; and no sense of making conjectures, or evaluating mathematical assumptions" (Richards, 1991). In the case of Samoa and for the purpose of this paper, the most important questions are: (1) What can be done to improve the quality of mathematics teaching and learning in Samoan schools? (2) How can the communication between researchers at NUS and practitioners in schools be maintained? Answers to these questions would offer guidelines to improve the teaching and learning of mathematics courses offered for teacher education programs. Doing so

would at least impact on the quality of teacher preparation and continuing professional development programs in mathematics.

The next section briefly discusses various beliefs and philosophies of mathematics as a discipline, which could assist mathematics teachers in re-assessing the way mathematics ought to be taught and learnt in Samoan classrooms.

Philosophies of Mathematics and Mathematics Education

Mathematics is often viewed as a formal logical deductive system from given primitive axioms in which truth is established by a formal set of syllogisms. The meaning or significance of a mathematical statement is extracted by interpreting its relationships to the formal system (Schoenfeld, 1991). Overall, a discipline is generally viewed as having its own "superordinate, general concepts and its categorical and causal relationships" (White, 1982); "... its within-field and outside-the-field values; ... its agents and audiences (the so-called "community of scholars"); and ... its phenomena of interest (that it) deals with, the occasions which give rise to the *quest* for knowledge" (Gowin, 1981). Hence, mathematics knowledge may be seen as a cultural product, in the sense that its overall context, its direction of movement, respond to the pressures of society (Hersh, 1994). Through publications, conferences and professional discussions and communications, mathematicians engage in warranting mathematics knowledge. This is a social process (Manin, 1977). According to Ernest (1999, 1994a), a revolutionary new tradition in the philosophy of mathematics is primarily naturalistic concerned with describing the nature of mathematics, its history and applications including the practices of mathematicians, and the place of mathematics in human culture. Like science, mathematics can advance by making mistakes, correcting them and recorrecting them.

In contrast, from the socio-linguistic perspective, if language is viewed as a conveyor of information and a means of situating people in a social system, then mathematics learning may be viewed as a task practiced by communities in terms of linguistic discourse enacted by its members. Richards (1991) defines four such types of communities as *research maths, inquiry maths, journal maths, and school maths. Research maths* is spoken mathematics of the professional mathematician and scientist while *inquiry maths* is the mathematics used by mathematics literate adults. In comparison, *journal maths* is the language of mathematical publications and papers whilst *school maths* is the discourse of the mathematics classroom in which mathematics is taught consisting of a body of facts and procedures to be learnt. In this view, if students are to have a view of *mathematics as a socially constructed body of knowledge* then they should be enculturated into the practice of mathematicians by learning to be mathematics literate (*inquiry maths*). That is, students need to *think, discuss, and act mathematically*. Teaching and learning mathematics therefore involves being initiated into mathematical ways of knowing, ideas and practices of the mathematical community and making these ideas and practices meaningful at an individual level (Ernest, 1999, 1998, 1994b). Thus, if mathematics learning is viewed both as a process of *active individual construction*, and a *process of enculturation* into the mathematical practices of a wider society, then the aim of mathematical classroom practices ought to include *equipping students with the appropriate language and skills to enable them to construct* for themselves the mathematics that is taught, and critically analyze and *justify* their constructions in terms of the structure of mathematics. Hence, students must engage in a mathematical discussion with others thereby practicing or being enculturated into the community of mathematical literate adults. In general, individuals (such as teachers) use their personal knowledge of mathematics and mathematics education

to direct and control mathematics learning as conversation both (a) to present mathematical knowledge to learners directly or indirectly (i.e. teaching); and (b) to participate in the dialectical processes of criticism and warranting of other's mathematical claims (i.e. assessment) (Ernest, 1999). Thus, teachers' beliefs of what mathematics is can influence the way he or she teaches and assesses mathematics in the classroom. For example, depending on the teacher's beliefs mathematics may be taught as a linguistic discourse in which two-way conversations and discussions are a major part of the lesson or it may be a one-way delivery of information with very little participation on the part of students.

From the discipline's perspective, if mathematics is viewed as a subject with a conceptual structure that guides its methods of solving problems then an effective problem solver is one that has a deep understanding of the structure of interconnections between mathematics concepts, principles, and formulas. Furthermore, such a problem solver can subsequently construct and demonstrate how this structure is linked to relevant methods of solutions, and vice-versa. This implies that students can actively construct their mathematical ways of knowing as they strive to make sense of mathematics. Thus far, teaching and learning a subject with a unique knowledge structure as a social process necessitates that both teachers and students can communicate competently and effectively as well as perform efficiently. Hence all participants need to understand the language that is used and possess the appropriate skills to assess tasks and perform competently. If students are not able to solve problems competently, this implies that they may have misinterpreted given problems, do not understand the mathematics involved, and/or are unable to systematically apply their knowledge to problems (White & Gunstone, 1992, 1989). Therefore, the ability to solve a problem successfully is dependent on how well a student understands the relevant knowledge structure and whether or not he or she has good meta-cognitive skills. The later make students aware of the purpose of problems and enable them to monitor and control their own progress during the problem solving process.

In accordance with the socio-cultural perspective of mathematics learning as a process of enculturation into a community of practice and the discipline's constructivist view of a learner, the primary responsibility of mathematics teachers then becomes that of teaching "students to think, to question, and to probe, to get to the heart of the matter, to be able to employ ideas rather than to simply regurgitate them" (Schoenfeld, 1991). This is the challenge for all mathematics teachers and educators. Students at various levels should be mathematics literate. They should be able to understand the language of mathematics and communicate mathematics competently. Hence mathematics teaching and learning should include discussions of not only *how* (procedures) problems are solved but *why* (concepts, principles) methods are appropriate. The regular justifications of methods in terms of the structure of mathematics in primary and secondary classrooms can facilitate the development of a practical understanding of interconnections between mathematics concepts/principles and procedures. These elaborations would necessarily involve questions and answers as teacher and students strive to understand each other thereby encouraging students to become more mathematically literate; that is, become more able to think, discuss and act mathematically (Richards, 1991). Therefore, it is important to undertake research that investigate ways in which students can better understand the structure of mathematics and how this understanding could be effectively applied in solving problems. For example, we need to determine the mechanisms through which students effectively retain, control and apply their understanding of mathematics concepts and principles to the identification of multiple methods of solving problems.

Mathematics Education Research at NUS

Part of the University's efforts to redress the problem of high failure rates and poor mathematics performance was to conduct research to investigate ways in which students' mathematics literacy could be improved. The first research area examined the potential usefulness of concept maps and vee maps as meta-cognitive tools in learning mathematics. Concept maps are schematic diagrams of hierarchical inter-connecting concepts with linking words on lines describing the nature of the interrelationship. Vee maps are diagrams that illustrate both the conceptual framework of a problem and its methods of solutions. In completing vee diagrams, students are required to identify and provide relevant mathematics principles to guide the transformation of given information to determine methods of solutions. This act necessarily requires that students be well versed with the conceptual structure of relevant mathematics topics. Different levels of understanding may be manifested through students' completed concept maps and vee diagrams. The main aim is for students to systematically analyze the structure of mathematics knowledge with a view of using the conceptual analyses to identify (multiple) methods to solve difficult and novel problems. Findings from this research are useful in developing strategies to overcome the over-reliance of students on rote learning of procedures, which are often incorrectly applied when solving new problems. Instead, students are encouraged to search for viable connections between relevant concepts, principles and methods across related topics (Afamasaga-Fuata'i, 1998a, 1998b, 1999a, 1999b).

The second research area examines students' strategies for determining modeling functions directly from data values through an identification of characteristic patterns of rates of changes for polynomial and transcendental functions. The use of data values as the starting point of investigation is mainly to provide students with another means of identifying functions other than the over-emphasized algebraic and graphical approaches prevalent in mathematics classrooms. Furthermore, this numerical approach has wider applications for modeling experimental data from scientific and statistical investigations. Results from this research would be useful in designing more challenging application problems to improve and enrich students' understanding of functional relationships that is crucial in school and advanced mathematics (Afamasaga-Fuata'i, 1998e, 1995).

The results of these on-going research are fed back to mathematics teachers and lecturers as part of their professional development activities in the form of publications, seminars, workshops, and upgrading programs within the Science Faculty (Afamasaga-Fuata'i, 1999a, 1999b). Public seminars are offered as part of the Science Faculty's development programs. Workshops are offered upon requests from the respective Directors of Education (such as the Congregational Christian Church's Director) and occasionally during school holidays sponsored by NUS to which local mathematics teachers and specialists are invited to attend.

Mathematics Professional Development Programmes at NUS

The University has been offering professional development programs in mathematics (both at pre-degree and degree levels) since 1992 which practicing mathematics teachers have utilized to upgrade their content knowledge (Afamasaga-Fuata'i, 1998c, 1998d). The pre-degree program provides an alternative pathway for practicing teachers (and since 1997, pre-service teacher trainees) to meet pre-requisites for entry into degree courses available for the Certificate, Diploma, Bachelor of Arts (BA) or Bachelor of Science (BSc)

majoring in Mathematics. Undertaking further studies in mathematics by practicing teachers had been and still is for a number of teachers, on an individual basis and self-funded. However, it was not until 1998, that the DOE launched a Samoa-Peace Corp Scheme which enabled Samoan school teachers to undertake professional development programs at NUS for two years while Peace Corp Volunteers take over their teaching responsibilities in the schools. In addition to formal courses in mathematics, teachers were also invited to attend subject workshops that focussed on particular problems related to mathematics teaching on a fortnightly basis during the semester. The first and second group of science and mathematics teachers have already graduated and are now back in their former schools.

On the other hand, the 1997 merger of the Secondary Teachers College with NUS as the Faculty of Education meant that the MSD was directly responsible for teaching the mathematics content courses for the pre-service teacher trainees. This involvement provided the vital link for the MSD to be involved in the pre-service program to complement their departmental efforts with practicing schoolteachers. For example, mathematics lecturers not only teach the teacher trainees mathematics but they also coordinated and offered workshops for some mathematics school teachers and curriculum specialists from the DOE (Afamasaga-Fuata'i, 1999b).

The impact of these development efforts on student learning in the classroom remains to be seen. There is still a lot that needs to improve in the classroom in terms of student educational resources and support before any major improvements in national results can be seen in the near future.

Conclusions and Recommendations

National results in mathematics can be improved if the quality of teaching in the classroom improves. This necessitates providing enough institutional support and educational resources to teachers and students so that they could get on with the job of teaching and learning respectively. The DOE is currently engaged in an institutional strengthening project mainly focussing on the personnel, and facilities in and around the main educational compound in Apia in an effort to improve the delivery of efficient services to schools around the country. Other sub-projects include those developing national strategies for the provision of special needs education, and writing of student materials for primary and secondary levels to supplement teachers' curricular manuals. Some student booklets have been distributed already to schools. These are all necessary developments. However, it is vital that needs of students in the classroom are adequately met and supported by ensuring that sufficient quality educational resources (textbooks and related reading materials) are accessible to supplement blackboard work by teachers. There is a scarcity of reference materials and basic mathematics textbooks in most classrooms.

Secondly, teachers need to participate in professional development activities on a regular basis to refresh, upgrade and review their outlook on teaching mathematics. The opportunity to share similar concerns and experiences with other mathematics teachers in Samoa can contribute positively to teachers' own self-esteem and confidence as educators. Hence, there is an urgency for the DOE and NUS to work collaboratively in developing guidelines and implementing strategies whereby the two institutions can fully utilize the expertise available locally in Samoa to develop professional development activities tailored to impact on mathematics learning in local classrooms. As a nation, we should refrain from imposing readymade programs exported from overseas without first undertaking extensive research concerning their applicability and suitability in the Samoan

context. It is recommended therefore that there be adequate institutional and financial support available for conducting research in Samoan mathematics classrooms to guide the development of suitable professional development programs.

The current arrangement for workshops mostly funded by the MSD is mainly the result of aggressive efforts by enthusiastic members of the department to share their experiences with the practitioners in the field. This is largely an effort to develop closer links between the school system and the University to minimize the widening gap between Year 13 and UPY mathematics. As the standard of NUS degree courses in mathematics are comparable to those offered elsewhere in overseas universities, lowering the entry requirement for UPY mathematics will be detrimental to those wishing to undertake further studies. Therefore, there is a need to review the entire national curricula in mathematics at all levels to avoid the overloading of topics at the senior secondary end. For example, some of the topics that are currently in the national Year 12 and Year 13 mathematics curricula should be re-distributed further down to Years 9 to 11. Similarly, the primary mathematics curricula ought to be reviewed to facilitate transition into secondary level by ensuring that pre-requisites are adequately covered by the end of Year 8. This review may be effectively done if one national mathematics committee is set up to monitor and oversee this exercise. At the moment, there seems to be two separate groups of individuals working independently, one working with primary and the other with secondary mathematics curricula. Furthermore, even within the secondary level curriculum writing projects, there is a lack of real communication between those working on the Year 12 curriculum development and those for the Year 13. This results in confusion and misinformation about what needs to be done to narrow the gap between Year 13 mathematics and UPY minimum entry requirements. A similar gap also exists between Year 12 and Year 13 mathematics curricula. This concern led the MSD in 1997 to initiate a series of meetings with secondary school teachers to discuss a possible national curriculum in mathematics that meets both the needs of the PSSC examination and UPY entry requirements (Lei Sam, 1998). Various members of the MSD department are involved in the curriculum writing projects for both primary and secondary levels as individuals.

The MSD has initiated a textbook writing project geared at the Year 13 level, which incorporates some of the ideas and findings from the concept mapping and vee mapping research. This initiative is slow as those involved have other full-time commitments they could not be released from. Some lecturers are also examiners and markers for national and the PSSC examinations on an individual basis. The challenge for all concerned is to put in place an institutional agreement between DOE and NUS whereby the professional expertise available at NUS is fully utilized by the DOE. Such available manpower may be utilized to develop national mathematics curricula for all levels, organize and coordinate regular mathematics workshops in conjunction with the MSD's involvement in the pre-service program. Such an involvement (pre-service plus in-service) represents a more concerted and integrated approach to improving mathematics education in Samoa. It also provides an ideal opportunity for mathematics lecturers to provide regular feedback and offer expert assistance directly to those who are teaching at primary and secondary levels based on their research and experiences as post-secondary mathematics teachers, examiners, and markers of national and regional examinations. After all, the products of primary and secondary schooling eventually end up in post-secondary classrooms.

In conclusion, the existing research and professional development programs already established at NUS by the MSD department is only a start. It needs to expand nationally to include all those who teach mathematics nationwide. Having said that, there is then a need

for adequate institutional financial support for offering such workshops. These professional gatherings would allow teachers to exchange experiences and ideas on how mathematics learning could be improved with those teaching and researching at post-secondary level. Finally, it is recommended that all mathematics teachers undertake professional development programs at NUS for two to three years supplemented with regular participation in workshops and seminars to maintain the free flow of information that will be useful for their classroom teaching. The formal institutional collaboration sought between DOE and NUS may not solve all problems in the short-term but it is certainly a positive step in the right direction in trying to improve the quality of mathematics teaching and learning in Samoan schools.

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